

W. H. Gour,
with W-Z's
OBSERVATIONS

best respects

ON

THE VINEGAR PLANT.

BY

W. FRASER, M.R.C.S E

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OBSERVATIONS

ON

THE VINEGAR-PLANT.

MOST, if not all of you, gentlemen, * are, I have no doubt, aware that a new process for the making of vinegar, of great simplicity and certainty in its nature, and especially adapted for domestic employment, has of late been very extensively introduced into this country. It is not quite a year since I first heard of it, and I can trace it no farther back than four or five years; and yet so completely and silently has it found its way into general use, that, from enquiries made on the subject, I believe that nearly one-third of the housewives of this town have already regularly adopted the process as one of their domestic arrangements. And in many other places its reception into favour has been equally rapid and complete.

So little, during all this time, does it seem to have excited the attention of the philosophical world that I have almost in vain looked for even a passing allusion to it in the scientific journals, or even in the newspapers. The only detailed notice of it I have succeeded in meeting with, is a short one in Chambers's Edinburgh Journal for December last—an article which I shall presently take occasion to refer to. The circumstance of its not having become a favourite or plaything of the savants, is perhaps fortunate rather than otherwise. Philosophic pets, like other pets, are very apt to be spoiled in their infancy, and prevented from arriving at a healthy or useful maturity. Its own intrinsic merits, and the successive recommendations of one thrifty housewife to another, seem quietly and gradually to have secured for it a place among the "household gods," from which it is not

* This paper was read before the Aberdeen Philosophical Society, in March, 1853; and subsequently at a Meeting of the Medico-Chirurgical Society. A few additions have since then been made to it.

likely soon to be dethroned. If it had been introduced to public notice by the prestige of some great name, and by the eulogies of learned societies, re-echoed through the public prints, the probability is that, like many other excellent inventions and processes so favoured, its merits would, in the first run of its popularity, have been overrated and exaggerated, and that in the reaction of public opinion which would naturally have followed, it would have sunk into an oblivion equally undeserved.*

In the instance of an article of such importance as vinegar must be allowed to be, in a domestic and dietetic point of view, as well as in reference to medicine and the arts, any process of production which, by its superior economy and simplicity, has been able, among so large a section of the community, to supersede all other sources of supply, and to establish itself so speedily in general use, is surely entitled to be considered as a great public benefit; and some enquiry into the subject will, I trust, not be considered to be useless or uninteresting.

On calling one day on a patient, I observed some vinegar employed, which was of a different appearance and flavour from ordinary, and on making a remark to that effect, I was informed that it was the produce of an "*American Vinegar Plant*," which the patient's wife had lately received from a friend. My curiosity was naturally excited, and I was glad to receive all the information on the subject they were able to give. While I was puzzling my brain to conceive what sort of a plant or tree it could be, that could have yielded so large a quantity of excellent vinegar, and in what manner the production could take place, the mistress proceeded to take out of a cupboard or pantry, a small basin, with a piece of chamois leather tied over its mouth. On the removal of this covering, there was exposed to view, floating on the surface of a brown liquid, and adhering by its circumference to the margin of the basin, a sort of skin, irregular and semi-gelatinous on its under surface, and smooth and light grey on its upper surface, having the appearance of a piece of moist

* "To give general currency to an hypothetical opinion, or medicinal reputation to an inert substance, requires only the talismanic aid of a few great names." "But, by bestowing unworthy and extravagant praise upon a remedy, we in reality do but detract from its reputation, and run the risk of banishing it from practice."—Paris' Pharmacologia, pp. 40, and 27.

parchment, or of boiled tripe, or still more nearly that of the fibrous or buffy coat which appears on the surface of a vessel of inflammatory blood. It seemed to be about an eighth of an inch in thickness, and on being removed and examined, was found to consist of two layers adhering slightly together, but which required great care in separating them, in consequence of there being some spots at which the adhesion was more than usually firm.

The process itself was described as follows :—Half a pound of treacle or golden syrup, and a quarter of a pound of common brown sugar, are dissolved in from two to three English pints of water contained in a basin or wide mouthed vessel; a layer of the plant is then spread evenly on the surface, and after being covered over in such a way as to exclude the light without entirely preventing the access of air, the vessel is to be set aside in a dark place, and, if in cold weather, in a kitchen or other position where it could receive the influence of heat. In a period, varying from two to eight weeks, according to circumstances—for example, the season of the year, the heat, the quantity of material to be acted upon, the extent of surface exposed to the air, and the size and healthiness of the plant employed—the liquid will be found to be changed into vinegar of an agreeable taste and aroma, and a second plant to have formed upon the surface of the first one. The two layers can be separated, and each used again for making an additional supply of the acid. Before being bottled and set aside for use, the vinegar ought to be subjected for a few minutes to the process of boiling.

Such was the information communicated to me on my first becoming acquainted with the vinegar-plant, and it substantially corresponds with my subsequent experience of it. After reading the article in Chambers's Journal, which was before alluded to, I shall give you the result of a few imperfect observations I have made on the subject :

A few years ago, the attention of domestic circles began to be aroused by the reported introduction 'from India' of a wonderful plant possessed of the property of converting treacle and other saccharine fluids into excellent table-vinegar. This rumour created an inquiry after the plant by thrifty housewives; and the excitement subsequently produced by the frequent suggestion of the subject at dinner-parties, led to the speedy diffusion of the vinegar-plant as a useful, we might

almost add, indispensable article in private families. Nor was this retarded by the reports promulgated by some mischievous botanists, that the use of vinegar so produced would insure the development of vinegar-plants in the stomach!

The vinegar-plant does not exhibit any of those peculiarities which our ordinary ideas associate with a *plant*. It may be described as a tough, gelatinous substance, of a pale-brownish colour; and to nothing can it be more appropriately compared than to a piece of boiled tripe. It is usually placed in a small jar containing a solution of sugar, or a mixture of sugar, treacle (or golden syrup), and water; and after being allowed to remain for six or eight weeks in a kitchen cupboard, or other warm situation, the solution is found to be converted into vinegar, this change being due to a kind of fermentation caused by the plant. While this change is going on, the further development of the plant proceeds: it divides into two distinct layers, which in course of time would again increase in size and divide, and so on, each layer being suitable for removing to a separate jar for the production of vinegar. The layers may also be cut into separate pieces for the purpose of propagating more freely. The solution necessarily causes the vinegar to be of a sirupy nature, but not to such an extent as to communicate a flavour to it; when evaporated to dryness, a large quantity of saccharine matter is left.

When this remarkable production was brought before the notice of scientific men, it was difficult to form an opinion respecting it. The microscope shewed it to have an organised structure; but its peculiar character, and its remarkable *mode of life*, differed entirely from any other known production. It has been instrumental, however, in opening up a new field of inquiry, and recent investigations shew that it is not a solitary form of organic life.

The vinegar-plant has been assigned a place in the large and obscure order of fungi. It is, in fact, a familiar species of mould, but in a peculiar stage of development. Dr Lindley and most other botanists regard it as the *Penicillium glaucum* (Greville). To give a correct notion of the true character of this abnormal production, it is necessary to allude briefly to the mode of development in fungi.

The fungi or mushroom family form an order of the class Cryptogamia (flowerless plants), and in their structure are entirely cellular—that is, their whole substance is composed of simple cells varying in form and arrangement in the different species. In the fungus there are two distinct systems—the vegetative and reproductive. The vegetative system consists of variously modified filaments, generally concealed in the earth or other matrix on which the fungus grows, and is the mycelium or spawn. This spawn is well-known in horticulture, being used for the production of mushrooms. The reproductive organs consist of spores, or spherical cells, very minute, but performing the part of seeds in the higher plants; these spores are sometimes supported on simple filamentous processes; but in the common mushroom we find the gills on its under-side to be the part whereon they are produced, the whole of the mushroom which we use belonging in fact to the reproduc-

vite system. Now, in its perfect state, the vinegar-plant presents all the usual appearance of common mould. But in the state in which we have it in an acetous solution, only the vegetative system, or the spawn, is developed, and developed to an extraordinary extent—consisting, when viewed under the microscope, of filamentous threads capable of producing the fructification or perfect mould whenever they are subjected to the proper conditions. These cellular filaments by being so closely interlaced together, give the peculiar leathery appearance exhibited by the vinegar-plant. Whenever the vinegar is allowed to evaporate, and the mycelium to become free from saturation, then the usual form of the mould is produced.

This is not the only instance of the mycelium of a fungus developing itself naturally in an abnormal condition without producing organs of reproduction. According to Dr Lindley, 'it is probable that the flocculent matter which forms in various infusions when they become "mothy," and which bears this name, is only the mycelium of *Mucor*, *Penicillium*, and other fungals of a similar nature.' It is not only in stale vinegar, in wine bottles, in empyreumatic succinate of ammonia, and in saccharine solutions, that such fungoid growths appear. Who is not familiar with the tough mass that is so often brought up on the point of the pen from the inkholder? It, too, is of the same nature, and like all similar productions, is especially rife in hot weather.

It must not be supposed that what is usually called the vinegar-plant is always the mycelium of *Penicillium glaucum*. There may be many distinct species which assume the form when placed under the required conditions, and all of them may have the power of producing vinegar.

Mould of various kinds, when placed in sirup, shews the same tendency as the vinegar-plant to form a flat, gelatinous, or leathery expansion. This is well shewn by Professor Balfour, in a paper recently laid before the Botanical Society of Edinburgh, 'On the Growth of various kinds of Mould in Sirup.' The results of his experiments are as follow:—

I. Some mould that had grown on an apple was put into sirup on 5th March, 1851, and in the course of two months afterwards there was a cellular, flat, expanded mass formed, while the sirup was converted into vinegar. Some of the original mould was still seen on the surface, retaining its usual form.

II. Mould obtained from a pear was treated in a similar way at the same time; the results were similar. So also with various moulds obtained from bread, tea, and other vegetable substances, the effect being in most cases to cause fermentation, which resulted in the production of vinegar.

III. On 8th November, 1850, a quantity of raw sugar, treacle, and water, was put into a jar, without any mould or other substance being introduced; it was left untouched till 5th March, 1851, when, on being examined, it was found that a growth like that of the vinegar-plant had formed, and vinegar was produced, as in the other experiments. The plant was removed into a jar of fresh sirup, and again the production of vinegar took place.

IV. Other experiments shewed, that when the sirup is formed from purified white sugar alone, the vinegar is not produced so readily, the length of time required for the changes varying from four to six months. There may possibly be something in the raw sugar and treacle which tends to promote the acetous change.

The professor exhibited specimens of the different kinds of mould to the meeting, some in sirup of different kinds, and others in the vinegar which had been formed. Several members of the society expressed their opinions on the subject. Dr. Greville remarked, that he had no doubt of the vinegar-plant being an abnormal state of some fungus. It is well known that many fungi, in peculiar circumstances, present most remarkable forms; and Dr. Greville instanced the so-called genus "*Myconema*" of Fries, as well as the genus "*Ozonium*." Even some of the common toad-stools, or "*Agarics*," present anomalous appearances, such as the absence of the pileus, &c., in certain instances. The remarkable appearances of dry-rot in different circumstances are well known. Although sirup, when left to itself, will assume the acetous form, still there can be no doubt but the presence of the plant promotes and expedites the change. Professor Simpson observed, that the changes in fungi may resemble the alternation of generations so evident in the animal kingdom, as noticed by Steenstrup and others. In the "*Medusæ*" there are remarkable changes of form, and there is also the separation of buds, resembling the splitting of the vinegar-plant. Mr. Embleton remarked, that in the neighbourhood of Embleton, in Northumberland, every cottager uses the plant for the purpose of making vinegar.

From the account we have given of the vinegar-plant, it will be seen that the numerous reports as to its introduction from India and other distant climes are probably without foundation. Whatever may be the history of individual specimens, certain it is that the plant in question is a native production. It will also be seen by those acquainted with botanical investigations, that the great difficulty in arriving at correct conclusions respecting the plant, was the absence of properly developed examples. We still want investigations as to the *species* which undergo this remarkable development. The recent researches of the Rev. Mr. Berkeley and others shew that the fungi, above all other plants, are pre-eminent for abnormal variation.

We ought to observe, that the remarkable mode of propagation possessed by the vinegar-plant—in the absence of reproductive organs—by means of dividing into laminæ, is quite in accordance with the merismatic division by which many of the lower *algæ* propagate.

The following are the different steps in the process of acetification, so far as I have been able to observe them. In the course of a few days, say from four to five or six days, if the weather be genial and favourable for the purpose, the upper surface of the plant, which usually sinks to the depth of a quarter or half an inch in the liquid, is found to be

covered to the depth above named, with a transparent gelatinous-looking substance, not unlike frog-spawn, which gradually acquires coherence and density. Whether it be from the two layers rising to the surface, or from evaporation, or other transposition of the fluid, at the end of the second or third week, the pair of plants are generally found to be at the extreme surface of the liquid; and at this time it is, while the gelatiniform substance alluded to. is consolidating into form and consistence, that the process of acidification seems to go on most rapidly and successfully. During some days—from two to four or five, according to the rapidity with which the action is proceeding—an agreeable, sweetish, and somewhat vinous odour, not unlike that of a fermenting vat, and often sufficiently strong to fill a whole room, is given out. When this odour has ceased, the process may be considered to be complete, and the plants should be separated and transferred to other vessels prepared for further use. If the liquid should be found, as not unfrequently happens, still to contain a portion of unreduced sugar, and if it be wished to bring it more completely into the acetous state, all that is necessary to do, is to set it aside for another period, after having replaced the plant upon it. The same process, though with diminished vigour, will be repeated, and a third but feebler plant, will be added to the two former ones. If left undisturbed for several months, a reproduction will take place at every succeeding period, but each successive layer will become thinner and thinner, and the liquid, instead of acquiring more acidity, will at last become exhausted of its strength, and vapid, and useless. The first or undermost layers will, after a time, grow soft and rotten, having died I imagine, and at last the whole mass of plant will undergo the same change, and its surface will become covered with mould, like that of any other decaying vegetable substance. The chief condition of success is to stop the process, and remove the vinegar, whenever the whole of the sugar is decomposed, and before the plant has begun to act upon the vinegar itself.

Many people, to save trouble, and for the sake of increasing the strength of their vinegar, as they suppose, allow the plant to remain in a large jar, without removing or separating it, till it acquire an immense thickness, withdrawing the vinegar occasionally, and adding an occasional supply of

saccharine liquor. But this method appears to me to be both slovenly and uneconomical, and the vinegar afforded by it cannot but be deteriorated in quality. It could not be expected that a wholesome or pleasant product could be the result, when such a mass of putrifying matter is left macerating continually among the contents of the vessel. The newer and fresher the plant that is employed, and the more pure and cleanly everything connected with the process is kept, the better will be the quality of the vinegar produced.

I shall now detail a few experiments made on the subject last summer, although, from having had no other object in view at the time, than the satisfaction of my own curiosity, I regret that I have only my memory to trust to, having taken no notes except in three or four instances.

Unless otherwise mentioned, it is to be understood that the materials used in the experiments, were the same as described at the commencement of these remarks, namely, in the proportion of half a pound of treacle and a quarter of a pound of raw sugar, to about two and a half or three pints of water.

EXPERIMENT I.

In a basin of the material, which was allowed to stand in a grocer's shop, covered only by a piece of brown paper laid over it, for ten or twelve weeks, during the months of August, September, and October, the liquid had, at the end of the time mentioned, diminished to one-fourth of its original quantity, and the plant had increased to three-quarters of an inch,—more than twelve times its original thickness. It was of more than the usual firmness, was divisible into four or five layers, and weighed nearly a pound,—almost the weight of the treacle and sugar that had been made use of. The vinegar produced was at no time strong or good, and ultimately it was nauseous and effete.

II.

The usual solution and plant, contained in a glass jar, were placed in a cupboard or press, the door of which, from being occasionally left ajar, admitted a little light in one direction. The new plant not only grew thicker and stronger in this direction than in the opposite, but, in the course of two months, it had crept up or extended itself upon that side of the glass, to at least an inch above the liquid underneath. And it retained its freshness and life

longer, I think, than if it had been entirely deprived of the light.

III.

Instead of employing a plant, about eight ounces of the recently-made vinegar itself was mixed with four or five times that quantity of the usual solution, and placed in a covered vessel, in the dark. In about ten days, it became studded over with a great number of whitish specks, throughout which the usual layer of gelatiniform matter, condensing into a membranous expansion, gradually made its appearance. This soon became covered with a beautiful corrugated or reticulated and downy surface of light-grey mould. On three or four occasions, on which this experiment was repeated, the same appearance, with slight variation, took place. The vinegar, in every instance, was nearly equal to that produced in the ordinary way. But if any of the feathery mould alluded to, was allowed to fall into the liquid—which, in the process of separating them, it was almost impossible to avoid—a perceptibly mouldy taste was communicated to the vinegar, which was sufficient to spoil it for ordinary use. When boiled vinegar was used in the experiment, no appearance of plant, nor any other unusual effect, took place, shewing that, as might be expected, the vital principle of the vegetable is destroyed by boiling.

IV.

When a vessel, containing the vinegar plant and solution, is left uncovered, or but slightly or inefficiently covered, it is very apt to become coated over with patches of mould; and this is more especially likely to occur, if the situation be within reach of anything of a mouldy or unclean description. The spores of some species of mould seem to be so universally diffused, to be so light and easily wafted through the air, and to vegetate so readily when brought into contact with a congenial soil, that there is a risk in uncovering the plant before the process be completed, in almost any situation where it can be placed.

V.

A small portion of strong liquor ammoniæ, mixed with the solution and plant—half a drachm to the pint—had the effect of completely preventing the usual development of new plant, and production of vinegar.

VI.

It occasionally happens that portions of air collect on the top of the solution, and are retained in bubbles beneath the surface of the plant. On several occasions on which I collected and examined this gas, there was reason to believe that it consisted almost entirely of nitrogen. On being shaken with lime water, it neither rendered the liquid turbid, nor was any portion of it absorbed; and it instantly extinguished a taper when introduced into it. This air appeared to result from the partial decomposition of the plant, and never occurred when a perfectly fresh and healthy plant was employed.

VII.

A small bit of the plant—about a square inch—placed on the top of the saccharine liquid, gave origin to a new plant, which covered the entire surface, but which was thicker and stronger in proportion to its vicinity to the parent plant.

VIII.

In a deep glass jar, in which the plant and solution were contained, at no period of the process—not even when the peculiar aceto-saccharine odour, before alluded to, was at its height—was a light extinguished by being introduced into the jar.

IX.

On the 25th of October, I placed, in a wide-mouthed, glass-stoppered bottle, a quantity—about twelve ounces—of the usual solution, so as almost to fill the vessel. The surface was then covered with a piece of plant, the stopper was firmly adjusted in its place, and the edges covered with melted sealing wax, so as completely to exclude the external air. To ensure the same object, a piece of leather was put over the stopper, and firmly tied round the neck of the bottle. The whole was then put in a place seldom exposed to the light. On the 4th of December, after an interval of more than five weeks, I observed that there had been a slight oozing at one point, and that part of the leather was saturated with liquid. On removing the stopper, I found that there had been no reproduction of the plant, but that it was reduced to a soft and apparently half rotten state, and that the liquid had acquired a beerish, agreeable smell, and a pungent, sweetish taste, somewhat like those of ginger beer—in fact, that it had undergone the ordinary vinous

fermentation. There was almost no sedimentary deposit, nor was there the slightest taste or indication of vinegar. The changes that had occurred were merely such as would probably have taken place if there had been nothing but the saccharine solution present, along with some decaying vegetable matter to act as a ferment. On allowing it to remain, however, for another period without the stopper, a regular plant quickly made its appearance, and the sugar that was present underwent the usual acetous transformation.

X.

A plant that had been boiled in water, did not produce the usual effect upon the solution: on the contrary, it soon underwent putrefactive decomposition, and became covered with vegetable mould. But, happening to look into the basin after a further interval of three months, I found that the solution had become acetous, a new plant having formed on the surface, and the old one having sunk to the bottom.

XI.

A piece of plant, hung up in the air to dry, had, at the end of a week, lost nine-tenths of its original weight. Another piece, by being deprived of its liquid by pressure between the folds of a cloth, and gentle drying before a fire, acquired very much the appearance, colour, and flexibility, of a piece of oiled-silk. It was of about the thickness of cartridge paper, smooth, soft, semi-transparent, and capable of being crumpled together without injury. It had the strength and consistence of a piece of leather. It sank in water. A bit of it placed in the saccharine solution, remained at the bottom, and regained scarcely any of its original plumpness or appearance. Its virtue was, however, communicated to the liquid, which underwent the usual change, becoming covered, in about the ordinary time, with a thin plant on its surface, which, as in the instance where the vinegar instead of the plant was used, became soon coated with a fine grey or faint green mould.

XII.

A plant, consisting of several layers, was boiled in three successive waters. Its weight and thickness were scarcely altered, but it had acquired increased opacity and firmness, and its colour was changed to a pure white. On being placed between folds of cloth, and the water pressed out of it by a roller, the layers were found to be almost entirely

separated, and merely lying in juxta-position. On being dried, these had very much the appearance of fine paper; the thinner ones being like tissue paper, the next like bank-note paper, than which, indeed, they were even more strong and difficult to tear, and the stouter ones like well dressed parchment.* The plant, when thus prepared, burned very readily, with a bright flame, and with a perceptible crackling noise, emitting a very slight ammoniacal odour, and leaving an ash rather more firm and bulky than that of paper. It underwent no change by soaking in water or vinegar, and it produced no perceptible effect on the usual saccharine solution when left in it. Dilute acids and alkalies, even when at the boiling temperature, exerted no perceptible action upon it. When exposed for a time to warmth, air, and moisture, it first became covered with mould, and then underwent a slow decomposition, becoming covered with brown or black spots from the liberation of carbon. Altogether, it exhibited much more of the negative and inert qualities of lignine or woody fibre, than of any of the other vegetable compounds which might be formed by the action of air and water on the elements of sugar.

XII.

A piece of fresh plant was fixed down at the bottom of the usual solution. A new plant, having a thin coating of mould, was formed on the surface, and the sugar became acetified in the ordinary way.

XIV.

Thinking it possible that other substances, of similar elementary composition to sugar, such as starch and gum, might afford nutriment to the plant, and become themselves changed into vinegar, I substituted solutions of these, in place of the usual saccharine solution. No farther acetification, however, took place, than could be accounted for by the fermentation that would naturally have occurred under the circumstances in which the substances were placed.

XV.

An ounce of the fresh plant, cut into small pieces, and mixed with bread, sugar, and milk, was readily swallowed as a meal by a small dog. No vomiting took place, nor did

* Specimens of these were shewn.

any suffering or inconvenience, either at the time or subsequently, appear to result. A cat, which was fed in the same manner, showed no symptoms of injury. Indeed, both animals ate the mixture very greedily, impregnated, though it necessarily was, with the vinegar, on several occasions on which it was offered to them.

XVI.

When distilled from a glass retort, through Liebig's condenser, the vinegar came over as strong, pure, colourless, and agreeable, as the ordinary distilled vinegar. When the operation was carried, however, beyond three-fourths of the quantity put into the retort, it fell off in quality, and possessed a slightly empyreumatic odour. The liquid remaining in the retort seemed a mixture of syrup, treacle, and vinegar.

XVII.

Instead of the usual solution, one of good refined sugar was substituted. The process went on so slowly, that even at the end of the third period or plant, the liquid had not acquired the acidity which is usually attained under the first crop of plant, when treacle is made use of. The new plant produced was thin, soft, and unhealthy, and the resulting liquid had not nearly the usual agreeable aroma and pungency. Nearly half of its sugar was evidently unreduced, and it could not be set aside without the risk of undergoing vinous fermentation, with a copious evolution of carbonic acid gas.

XVIII.

The mature plant, when examined under the microscope, appears to consist of a molecular substance, closely packed with cells of an oblong shape, resembling an almond, but rather more rounded at the ends, and having a dark spot or nucleus in their centre, with a corresponding depression on their surface. These cells, seeds, or spores, are very sharply defined, seem to have strong walls, and average about 1-2550th of an inch in length, by 1-4520th of an inch in breadth. Within the substance of the plant, the cells, or their collapsed and broken walls, are so closely crowded together, that it is almost impossible to make out either their exact individual appearance, or the precise mode of their arrangement. To see them distinctly, a small portion should be scraped with a penknife from the under surface of the plant, and laid, diluted with water, upon the field of the microscope.

As mentioned before, when placed in the saccharine solution, and so near the surface as to be easily acted on by the air, the plant within ten or twelve days, throws up, and becomes covered over with, a quantity of gelatiniform matter having a beautifully smooth, glassy, and apparently moist surface, but which does not wet the finger when it is gently touched. The microscope shews that this substance consists of innumerable cells, answering to the description that has just been given, embedded in a stratum of transparent matter, abounding in granules or particles so minute as to be almost invisible under the strongest power of the instrument. The process of reproduction in the plant, seems to be as follows:—immediately after being placed in the proper solution, the cells, which form so large a part of its composition, begin to enlarge, by the absorption and assimilation of both fluid and granular matter, and a corresponding extension of their own investing membrane or walls. They would seem to have the power of transforming the saccharine matter with which they are more immediately in contact, causing it to assume the coagulated and molecular character alluded to. In the course of a week, or longer or shorter, according to circumstances, two nuclei become apparent in each cell, occupying not the middle, but spaces near the opposite ends of the cell. The mobility of these dark spots or nuclei, and the gradual manner in which they become developed, by apparently loose granules in each cell coalescing and consolidating together, would seem to indicate that they are formed from the molecular matter of the medium by which the cells are surrounded. In the course of another week or less, one or two more nuclei often make their appearance, the whole number now generally arranging themselves at equi-distant points on the inner surface of the cell, seeming at last, from their pellucid and distended appearance, to be themselves converted into cells, causing now, instead of a depression, a bulging out, like the eyes or germinating points of seeds when about to bud, and thus giving to the parent cell, somewhat of the irregular appearance and shape of a kidney potatoe. And that they actually do bud, or rather burst, and put forth a series of new cells corresponding to the number of nuclei they contained, I have no doubt, although, in the course of hundreds of observations, I never succeeded in seeing the process of subdivision actually take place.

The probability of this being their manner of growth and reproduction, is still further confirmed, by the consideration that there is no other apparent mode in which these changes could take place; that the arrangement of the cells—in ramifications clustering round about a centre—is exactly such as would be produced by this mode of propagation; and that the double-nucleid, or polynucleid cells, which make their appearance at different stages of the process, are soon found to be replaced by an increased number of cells with single nuclei. The new cells, which are small at first, rapidly attain the normal size, and ultimately, if placed in favourable circumstances, undergo the same changes as the parent cells from which they were formed. The division, I think, frequently takes place on the maturation of two nuclei. though sometimes not till three, or four, or five have made their appearance. The cells developed in a solution of white sugar, though of the ordinary form and appearance, were not above a fifth part of the size of those produced in the usual solution, and they never seemed to attain above two nuclei.

A great number of isolated filaments and other portions of microscopic vegetables, of various size, colour, and appearance, will generally be found entangled in the substance of the vinegar plant. But the presence of these is entirely incidental, and, if not due to the contemporaneous growth of fungi, whose seeds had been deposited on the plant, may be readily traced to the treacle and sugar that had been employed, a microscopic examination of which materials, will shew that they are abundantly contaminated with such remains.

While the process of acetification is going on, although the cell-growth would seem to take place only at the surface, the entire mass of liquid is charged with the vinegar-cells, as may be proved by examining specimens taken from all parts of the containing vessel. In unboiled vinegar, however, that had stood for six months in an open wide-mouthed bottle, and the thin successive layers of plant forming on which, had been all removed, no vinegar-cells could be detected, but instead, a good many round unnucleied cells, much smaller and simpler in their structure, and apparently belonging to some lower species of fungoid.

In portions of boiled vinegar subjected to the microscope, no cells were visible, but, instead, a great number of bodies

like minute dark lines, none of them exceeding the length of a cell, and representing, probably, portions of the cell-walls, which had been over-distended, ruptured, and disintegrated, by the heat of boiling. The liberation of the contents of the cells, by the destruction of the latter during the act of boiling, accounts for a very decided increase of acidity which is communicated to the vinegar by this process.

A solution of treacle and sugar was made in a strong infusion of tea—a substance which contains nitrogen, and which from the readiness with which it gives rise to mould accompanied by an acetous change in the liquid, is sometimes used domestically for the production of an inferior kind of vinegar. A basinful of this mixture set in a dark place, and having several sheets of paper laid over it, was found, at the end of three weeks, to be covered with a thick coating of green mould growing upon a tough yellowish understratum, (*Penicillium glaucum*?) It had lost nearly all its sweetness, without acquiring almost any acidity. It had a bitter, nauseous, and mouldy taste. Viewed by the microscope, the understratum of mould appeared to consist of a thick web of capillary filaments, intermeshed in all directions, like the tangled roots of a bed of turf. At one extremity of these rootlets, the saccharine pabulum seemed to be imbibed—at the other, there were given off, in groups or flowerets, a number of small and perfectly round spores, measuring about a third part of the long diameter of those of the vinegar-plant. These were uniform in size, generally arranged themselves when in the liquid, in straight lines, and did not appear to enlarge, or to undergo any sub-division or change, like the cells of the vinegar-plant. The grey and green dust constituting the upper surface of the mould, seemed entirely to consist of these spores.

Another portion of the same solution had a vinegar-plant laid on its surface, and was covered, and placed in the dark as usual. At the end of the ordinary period, the plant was found in a soft, pulpy, decomposing state, distended with bubbles of gas, and covered with patches of mould. If any new plant had been formed, it was undistinguishable, having become involved in the general decay. These pulpy remains of the plant contained an abundance of vinegar-cells mixed together in all stages of their developement. Scarcely any of them, however, were found throughout the liquid,

but in their place, a considerable number of round single cells, and a great variety of amorphous fragments, apparently the debris of the decomposed plant. The liquid had very little acidity, but, along with some sweetness, a mouldy and unpleasant taste and smell.

These microscopic observations I give with the utmost diffidence, candidly acknowledging that I have myself far from entire confidence in their accuracy. My experience in microscopy is but recent and limited, and therefore perhaps not altogether to be depended on. At first, I intended to have availed myself of a promise of assistance, which so accomplished a microscopist as our vice-president, who is now in the chair,* had made to me on the subject, but I soon found from the very nature of the observations, requiring, as they did, to be taken in conjunction with a variety of other circumstances, that it was next to impossible to take advantage of his kind promise.

After giving the induction or inferences in part, that may fairly be deduced from these observations, I shall conclude with a few remarks by way of attempting an explanation or theory of the process.

The first inference that presents itself, is that the name vinegar-plant, though objected to by some, is a perfectly appropriate and correct designation. The substance is truly a plant, endowed with vegetable life, and subject to the usual conditions affecting the class to which it belongs. The access of light causes it to increase in strength and in size, and to grow towards the direction from which the light comes. The presence of air is absolutely necessary to its existence and growth; and it does not appear to deteriorate or carbonize the air, as is done in the ordinary fermentation which sugar undergoes, when its solution is left in contact with a fermentative agent. It speedily dies when air is withheld from it, and suffers decomposition. Its structure—cellular laminated, and filamentous—likewise shews its vegetable character.

As to the origin and history of the vinegar-plant, various ideas are current, but nothing very definite or certain seems to be known. Some maintain that it is no novelty, but a native production that has been long known in this country. Others think that, though of native origin, it is only of late

* Dr Redfern.

that the peculiar development of mould known by the name of vinegar-plant, has been brought to perfection, and cultivated for the purpose of vinegar-making. Many believe that it is of foreign importation, and has only lately been introduced into this country.

I confess I am inclined to take this latter view, for the following, among other reasons. First, because it is well-known that many specimens of it, within the last few years, *have been so introduced* from various quarters. Secondly, because in all the attempts to produce it that I have heard of, including some experiments by myself, in no instance has a specimen been procured by means of any of the moulds that are of spontaneous growth in this country, which has entirely resembled the vinegar-plant, or which has been nearly so efficient in the production of vinegar. Thirdly, because in tropical and warm climates, abnormal variations of vegetable productions, are much more likely to originate, and to become naturalised, than in this country. The process, upon the whole, seems to remind one a good deal of the ingenious resources which have been adopted by the Chinese, in several analogous departments of what may be termed domestic economy.

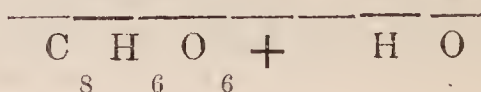
The process itself is probably of a chemico-vital nature—that is to say, it is a chemical action, to which a particular direction or tendency is given by the vital property of the plant, acting through the organism of its cells. It affords, in fact, one of the simplest examples of this sort of modified chemical affinity, which, there is reason to believe, is involved in the elaboration of the great majority of organic—and especially vegetable—products. Let us endeavour to work out the problem of the decomposition that takes place, by the assistance of the usual chemical formulæ.

From the elements of sugar, let us withdraw those of vinegar, and ascertain what substance will most nearly correspond in its composition to the group of elements remaining after the subtraction.

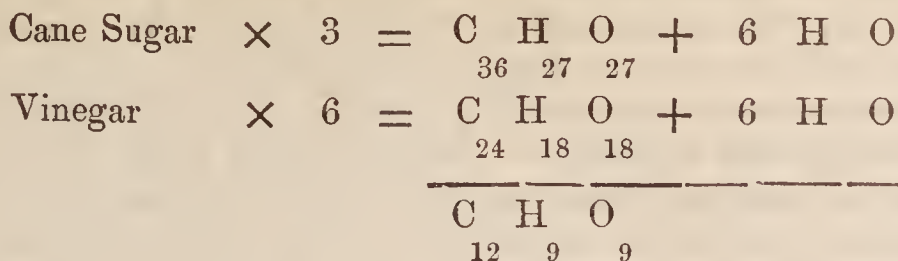
Cane Sugar,



Vinegar



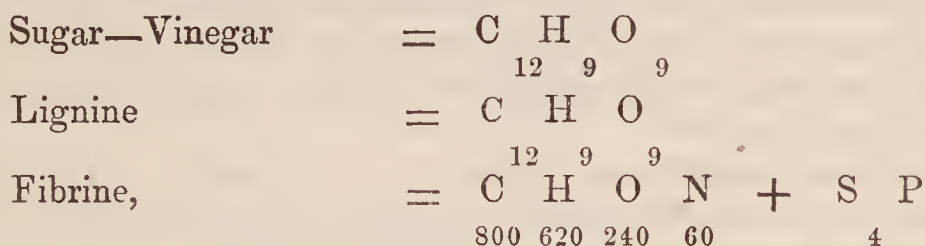
Or, in order to homologate the elements of the water with the general formula, let us withdraw *six* atoms of vinegar from *three* of cane sugar, and we would then have:—



On this supposition, every six atoms of sugar are resolved into three atoms of vinegar, and one of plant represented by



On referring to Gregory's Organic Chemistry, I find that this is the precise composition assigned to lignine or woody fibre,* the very substance, which, from the properties before described as characterizing the dried plant, one would naturally have fixed upon as being the resulting product of the decomposition. Although evidently containing a small portion of nitrogen, and thus approximating to the character of vegetable fibrine, the next substance which stands nearest to it both in general resemblance, and in atomic composition, it evidently much more nearly resembles Lignine, whether we judge from its actual appearance, or from the theoretical composition that has now been assigned to it. We have—



A single glance is sufficient to show that, while the proportions of the first and second groups of elements, are perfectly identical, those of the second and third are very far from being so.

Although no account is taken, in the foregoing hypothesis, of the action of the atmospheric air, which was previously shown to be indispensable to the process, it may not on that account be the less true, so far as it goes. One office evi-

* That of box or willow—See Gregory's "Outlines of Chemistry;" p. 557.

dently performed by the air, is to supply the nitrogen which the plant contains.

Besides the indication of nitrogen given to the sense of smell, by the combustion of the dried plant, its presence is likewise shewn by the facility with which the vegetable becomes covered with mould, a substance which is well-known to contain this element.* Indeed, as the plant itself may, from its botanical characters, be fairly considered as a species of mould, we are warranted by analogy to infer the presence of nitrogen in it. This element is, there is no doubt, derived mainly from the atmosphere, but I cannot help thinking that it is likewise, to some extent, supplied by the treacle, the extractive matter of which may contain a sufficiency of nitrogen for this purpose. If this be not the case, why is it that pure sugar, which undoubtedly contains no nitrogen, should succeed so imperfectly in developing the plant, and consequently in producing the vinegar. The point might perhaps be ascertained by a simple experiment, which I regret not to have included in the series before detailed. A glass jar containing common air, and perhaps provided with a tube and stopcock, for admitting of the collection of the gases evolved, and of the introduction of additional air when required, might be inverted over, and partly immersed in the contents of a vessel containing the usual solution and plant. At the end of the process, the gaseous contents of the jar, together with those that had been withdrawn from it, might be examined, and any alteration in their nature, whether from increase, diminution, or chemical change, could easily be ascertained.

When carefully made, the plant-vinegar has a very agreeable and aromatic flavour, not unlike that of the best French vinegars, which, it is well known, are, on account of their aroma, much more esteemed than those of this country. And the probability is that they both owe this valuable quality to the same cause, namely the development of aldehyde in the process of their manufacture, and the consequent formation and intermixture with the vinegar, of acetic ether.

An idea is prevalent, which has I believe, prejudiced many against using the produce of the vinegar-plant. I allude to the belief that, from the warmth and other favoura-

* Gregory's Outlines of Chemistry ; p. 502.

ble conditions existing in the stomach and in the body generally, a reproduction of the plant would take place, which might compromise the health and safety of the individual accustomed to use the vinegar. This impression may have arisen from the knowledge which the microscope has of late revealed, of such a source of disease as the *sarcina ventriculi*, being developed, and kept up by a continual reproduction of the fungus in the human stomach. The cryptogamic structure which this instrument has likewise shewn to belong to many eruptions both on the external and internal surfaces of the body, might also have given some plausibility to the belief. And there is no doubt that the dealers in vinegar take advantage of these circumstances to prepossess the public against making use of the vinegar-plant.

Such an idea might easily be shown to be groundless. In the first place, *no deleterious effects are observed to take place* from the use of the article. Secondly, the time which it requires for the ingesta to pass through the body, would not be nearly sufficient to admit of the maturation of the sporules of the plant taking place. Thirdly, if it were possible for the plant to become developed in the stomach, its digestion would speedily take place, and no harm could ensue. Fourthly, even if we could suppose that these germs passed uninjured through the primary or gastric digestion, their size and structure, taken in connexion with the nature of the lacteal absorption, would preclude the supposition of their being absorbed into the lymphatic and circulating systems; and, even if they remained long enough in the bowels, and met with saccharine nourishment sufficient to permit of their full developement into plant, it is difficult to conceive what harm could arise. Fifthly, there is one condition which appears to be essential to the growth of the plant—that of quiescence—which would be quite unattainable in whatever part of the body the seeds could find a lodgement. Sixthly, it seems to be so perfectly harmless in its nature, and so free from poisonous qualities, that it is difficult to conceive in what manner it could prove injurious to the system, whether introduced directly into it, or developed from seeds that had been swallowed. But the precaution—which is likewise rendered necessary for its proper preservation—of boiling the vinegar before setting it aside for use, is quite sufficient to do away with all such fears as those alluded to.

As an additional testimony in its favour, I may mention that, “The analytical sanitary Commissioner of the Lancet,”—an authority to whose verdict the public appear to attach no inconsiderable weight, strongly recommends the vinegar made by this process, for domestic use. After giving the analyses of a great many samples of vinegar, the produce of different manufacturers, and shewing that about four-fifths of them, are largely adulterated with sulphuric acid, he says: * “Families may manufacture for themselves by a simple process, the whole of the vinegar they require either for the table, or for the purpose of pickling, and so make themselves independent of the vinegar-maker, and ensure the purity of the article, and its freedom from oil of vitriol.” &c.

The months of July, August, September, and October, appear to be the most favourable for the process, and I think it is only during this period that the manufacture should be conducted. A sufficient quantity should *then* be made, to serve during the year, and a few plants should be preserved for subsequent use, by being placed in a moderate temperature, in a solution of white sugar, which, for this purpose, is preferable to the usual solution, as it will resist the decomposing action much longer. The utmost cleanliness and nicety should be maintained in all parts of the process, the admission of a few spores of mould, from any unclean substance, being enough to produce a growth of this parasite, sufficient to contaminate the whole liquid.

In order to compare this species of vinegar, both as to quality and cost, with that which is retailed in the shops, I yesterday sent for a quantity to the shop of a highly respectable druggist in town, who, I am sure, will not take it amiss that I mention his name—that of our excellent member, Baillie Urquhart—as this will afford a guarantee that the sample now produced is as fair a one, both as regards quality and price, as any that could have been procured. It was charged at the rate of sixpence for twelve ounces. Now, as the price of golden syrup, or the best treacle, is $2\frac{1}{2}$ d. per pound, and that of brown sugar 4d. per pound, the cost of three pints or pounds, or 48 ounces—or say 38 ounces (allowing a fifth part to be lost by evaporation, &c.)—of the vinegar made according to the usual formula, would

* Lancet for 28th August, 1852; p. 203.

be—half a pound of golden sirup $1\frac{1}{4}$ d. + a quarter of a pound of sugar 1d. = $2\frac{1}{4}$ d. Whereas the price of the same quantity of the retail vinegar would be nineteen-pence, or 1s. 7d., nearly nine times that of the other. The quality of the plant-vinegar appears to me to be likewise decidedly superior; but on this point you have now an opportunity of judging for yourselves.

In the analyses given in the “Lancet,” of 28 samples of vinegar made by the most celebrated manufacturers, the quantity of dried sub-carbonate of soda required to neutralise 1000 grains of the vinegar, ranges from 34 grains up to 58 grains. A thousand grains of each of the various specimens of plant-vinegar, now upon the table, and which are very far from being the strongest that could be made, I find require 43 grains for their saturation. Now, when it is taken into account, that of those 28 samples, only two were entirely free from sulphuric acid, and that some of the rest contained actually more of this than of the pure acetic acid, it must be admitted that the plant-vinegar is entitled to a very respectable position among the vinegars in general use.

Some cheap and easy mode of removing the unreduced sugar which it sometimes contains, would be an improvement in the making of the vinegar. For many purposes, the portion of undecomposed sugar that may remain, is no disadvantage, but rather the reverse. But, for other uses to which it is applied, the absence of the sugar would be a decided improvement. When used, for instance, medicinally as a lotion, it is apt sometimes to leave a brown and clammy coating on the skin, which must be allowed to be rather an objection to its employment for the purpose alluded to. Its colour may very easily be removed—though not without a little impairment of its quality—by filtration through animal charcoal (ivory black), but some easy and effectual method of removing its syrup, without our having to wait for its entire reduction by the plant itself, is still a desideratum. Possibly, the subjecting of it to fermentation, by the addition of a portion of yeast, might effect the object, although there would be a risk of this treatment decomposing and destroying also its fine ethereal aroma.

